

Ge-Zr evaluation contributed by J. P. Abriata and J. C. Bolcich, Centro Atómico Bariloche, Comisión Nacional de Energía Atómica, 8400 S. C. de Bariloche, Río Negro, Argentina; and D. Arias, Centro Atómico Constituyentes, Comisión Nacional de Energía Atómica, Avda. Gral. Paz y Constituyentes, Buenos Aires, Argentina. Literature searched through 1982. Dr. Abriata is the ASM/NBS Data Program Category Editor for binary zirconium alloys.

The Al-Pt (Aluminum-Platinum) System

26.98154

195.08

By A.J. McAlister and D.J. Kahan
National Bureau of Standards

Equilibrium Diagram

The Al-Pt phase diagram is complex. Certain of its features have been determined reliably. $Al_{21}Pt_8$, Al_2Pt , Al_3Pt_2 , Al_3Pt_5 , and $AlPt_3$ have been observed in two or more careful, independent studies and are established as equilibrium phases. Other aspects of the diagram are problematic. Some question has been raised as to the phase in equilibrium with (Al) and the liquid near 20 at.% Pt at 657 °C (although the weight of evidence favors the cubic $Al_{21}Pt_5$ phase). Debate also has occurred over the existence of the high- and low-temperature modifications of $AlPt_2$. The high-temperature β phase has been observed directly only once. The existence of the low-temperature modification of $AlPt_3$ remains a matter of debate. Finally, no confirming measurements of liquidus, solidus, and invariant temperatures exist.

The equilibrium phases of the Al-Pt system include:

- The liquid, L
- The fcc terminal solid solutions, (Al) and (Pt)
- $Al_{21}Pt_8$, complex cubic, with essentially no solubility range
- Al_2Pt , tetragonal, with essentially no solubility range
- Al_3Pt_2 , of cubic CaF_2 type, with a solubility range of about 1 at.% at 850 °C
- Al_3Pt_5 , with the structure related to but not isotypic

with hexagonal Al_3Ni_2 and essentially no solubility range

- $AlPt$, with the cubic FeSi structure and essentially no solubility range
- β , cubic CsCl type, occurring above 1260 °C, with approximate solubility range of 51 to 56 at.%
- Al_3Pt_5 , rhombohedral Rh_5Ge_2 type, with solubility range of 1 to 2 at.%
- $AlPt_2$, the high-temperature modification of $AlPt_2$, with Ni_2Si structure and solubility range of 1 to 2 at.%
- $AlPt_2(LT)$, the low-temperature modification of $AlPt_2$, with the $Pt_2Ga(LT)$ structure and solubility range of 1 to 2 at.%
- $AlPt_3$, with cubic Cu_3Au structure, and solubility range of about 10 at.%
- $AlPt_3(LT)$, a tetragonal variant of the Cu_3Au structure occurring below 1290 °C, with solubility range from about 74 to 78 at.% at 859 °C

Invariant temperatures and compositions are listed in Table 1, crystal structures in Table 2, and lattice parameters in Table 3.

Liquidus and Solidus. Liquidus and solidus data are shown in Fig. 1. Two thermal analysis studies of the liquidus and solidus have been reported. The first [12Chol, 12Cho2] covered the composition range 0 to 36.4 at.% Pt and was carried out on samples of doubtful purity. These

Table 1 Special Points of the Al-Pt Phase Diagram

Reaction	Compositions of the respective phases, at.% Pt			Temperature, °C	Reaction type
$L \rightleftharpoons AlPt_3 + (Pt)$	79.5	76.4	85.7	1507	Eutectic
$AlPt + L \rightleftharpoons \beta(a, b)$	50	53.7	51.5	1510	Peritectic
$L \rightleftharpoons Al_3Pt_2 + AlPt$	44.7	40	50	1468	Eutectic
$L + AlPt_3 \rightleftharpoons Al_3Pt_5$	62.3	67.3	62.5	1465	Peritectic
$Al_3Pt_5 + AlPt_3 \rightleftharpoons AlPt_2(b)$	62.7	67	67.5	1430	Peritectoid
$L + Al_3Pt_2 \rightleftharpoons Al_2Pt(a, b)$	31.8	40	33.3	1406	Peritectic
$L \rightleftharpoons \beta + Al_3Pt_5(a, b)$	55.7	57.9	66.5	1397	Eutectic
$AlPt_3 \rightleftharpoons AlPt_3(LT) + (Pt)(b)$	77.7	77	87	1280	Eutectoid
$\beta \rightleftharpoons AlPt + Al_3Pt_5(b)$	54.2	50	61.5	1260	Eutectoid
$L + Al_2Pt \rightleftharpoons Al_{21}Pt_8$	18.8	32.6	27.5	1127	Peritectic
$AlPt_2 \rightleftharpoons AlPt_2(LT)(a, b)$		67		1060	Unknown
$L + Al_{21}Pt_8 \rightleftharpoons Al_{21}Pt_5$	3.1	27.5	19.2	806	Peritectic
$L \rightleftharpoons (Al) + Al_{21}Pt_5$	0.4	0	19.2	657	Eutectic
$L \rightleftharpoons Pt$		100		1769	Melting point
$L \rightleftharpoons AlPt_3$		73.2		1556	Congruent
$L \rightleftharpoons AlPt$		50		1554	Congruent
$L \rightleftharpoons Al_3Pt_2$		40		1527	Congruent
$AlPt_3 \rightleftharpoons AlPt_3(LT)(b)$		76.5		1290	Congruent
$L \rightleftharpoons Al$		0		660.452	Melting point

(a) Invariant reaction temperature probably accurate to ± 10 °C, compositions to ± 1 at.%. (b) Reaction tentatively identified and discussed in text.

Table 2 Al-Pt Crystal Structure Data

Phase	Homogeneity range, at.% Pt	Pearson symbol	Space group	Strukturbericht designation	Prototype	Reference
(Al)	~0	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	[Pearson2]
Al ₂₁ Pt ₅	19.2	Cubic	...	...	...	[64Huc, 80Pia]
Al ₂₁ Pt ₆	27	<i>tI116</i>	<i>I4₁a</i>	...	...	[68Eds, 82E11]
Al ₂ Pt	31.5 to 33.5	<i>cF12</i>	<i>Fm3m</i>	C1	CaF ₂	[37Zin, 63Fer, 82E11]
Al ₃ Pt ₂	40	<i>hP5</i>	<i>P3m1</i>	...	...	[78Bha]
AlPt	50	<i>cP8</i>	<i>p2₁3</i>	B20	FeSi	[56Sch, 63Fer]
β	~52 to ~56	<i>cP2</i>	<i>Pm3m</i>	B2	CsCl	[78Bha]
Al ₃ Pt ₅	~61.5 to 63	<i>oP16</i>	<i>Pbam</i>	...	Ge ₃ Rh ₅	[64Huc]
AlPt ₂	~66 to ~67	<i>oP12</i>	<i>Pnma</i>	C23	PbCl ₂	[75Cha1]
AlPt ₂ (LT)	~66 to ~67	<i>oP24</i>	<i>Pmma</i>	...	GaPt ₂ (<i>l</i>)	[76Cha]
AlPt ₃	~67.3 to ~77.7	<i>cP4</i>	<i>Pm3m</i>	L1 ₂	AuCu ₃	[62Bro, 64Huc, 63Mag]
AlPt ₃ (LT)	~73.5 to 100	<i>tP16</i>	<i>P4/mbm</i>	...	GaPt ₃ (<i>l</i>)	[75Cha1]
(Pt)	~83.8 to 100	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	[Pearson2]
Metastable phases						
α'	...	<i>cF4</i>	<i>Fm3m</i>	A1	Cu	[64Com]
Al ₄ Pt	~20	Hexagonal	...	...	...	[78Sch, 80Pia, 82E11]
Al ₆ Pt	~14	Orthorhombic	...	...	...	[74Ton, 78Cha, 79Cha]
ϵ'	...	Cubic	...	...	...	[78Cha, 79Cha]
λ'	10 to 25	...	...	...	...	[82E11]

Table 3 Al-Pt Lattice Parameter Data

Phase	Composition, at.% Pt	Lattice parameters, nm			Reference
		a	b	c	
(Al)	0	0.40496	...	...	[Pearson2]
Al ₂₁ Pt	19.2	1.923	...	...	[64Huc]
	19.2	1.932	...	...	[80Pia]
Al ₂₁ Pt ₆	27	1.297	...	1.066	[68Eds]
	27	1.2964	...	1.0684	[82E11]
Al ₂ Pt	...	0.5992	...	...	[37Zin]
	...	0.5910	...	...	[63Fer]
	32	0.5920	...	...	[82E11]
	33	0.5910	...	...	[82E11]
Al ₃ Pt ₂	40	0.4208	...	0.5172	[63Fer]
	40	0.422	...	0.517	[64Com]
	40	0.420	...	0.517	[82E11]
AlPt	50	0.486	...	...	[56Sch]
	50	0.4864	...	...	[63Fer]
β	53	0.3125	...	...	[78Bha]
Al ₃ Pt ₅	...	0.541	1.070	0.395	[64Huc]
AlPt ₂	66.6	0.7898	0.5401	0.4055	[76Cha]
AlPt ₂ (LT)	66.6	1.630	0.392	0.544	[76Cha]
AlPt ₃	72.8	0.3871	...	...	[62Bro]
	...	0.3876	...	...	[64Huc]
	...	0.387	...	...	[63Mag]
AlPt ₃ (LT)	74	0.546	...	...	[75Cha1]
(Pt)	88	0.3905	...	...	[79Sch]
	90	0.3905	...	...	[62Bro]
	90	0.3905	...	...	[79Sch]
	92	0.3910	...	...	[79Sch]
	92.9	0.3911	...	...	[70Dar]
	94	0.3914	...	...	[79Sch]
	96.4	0.3917	...	...	[70Dar]
	97	0.3910	...	...	[79Sch]
	98.5	0.3920	...	...	[79Sch]
Pt	100	0.39239	...	...	[Pearson2]

Note: All measurements made at 25 °C, except β , at 1340 °C.

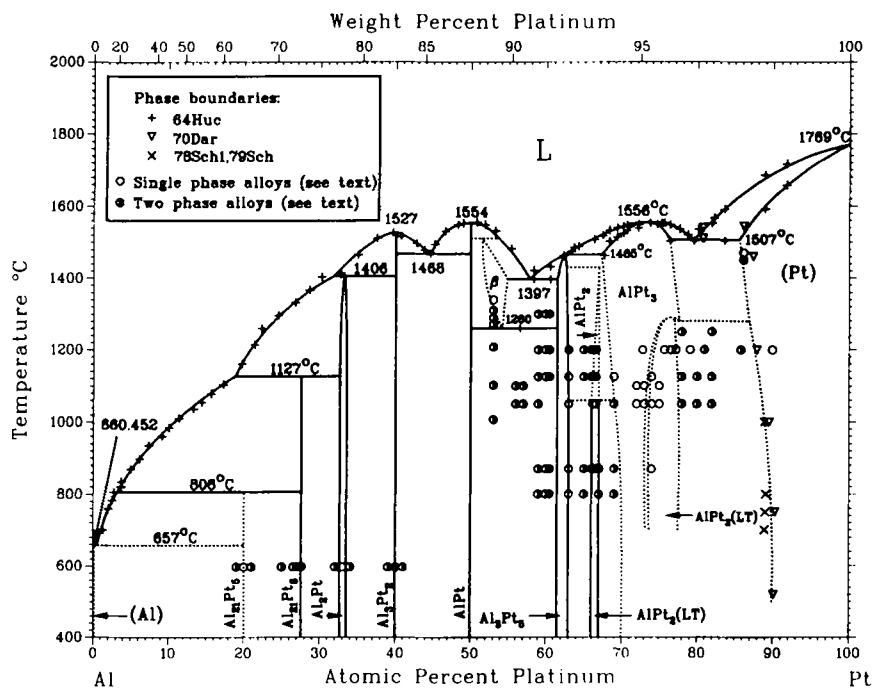
data are in serious disagreement with the later study of [64Huc] and were not used to place either the liquidus or

solidus. [64Huc] also carried out metallographic, XRD, and density measurements over the range 0 to 100 at.% Pt. The accuracy of their temperature measurements was probably no better than ± 10 °C. Although thermal analysis was performed in heating and cooling, it is not clear whether the reported arrest temperatures were obtained on heating or cooling, or were averages of the two.

[64Huc] reported an Al₂Pt₃ phase formed by a peritectic reaction at 1397 °C. Their XRD pattern for this phase shows strong AlPt lines, similar to but slightly shifted from those of Al₃Pt₅, and a few weak lines not related obviously to any other of the structures they reported. These XRD data argue not for the existence of an Al₂Pt₃ phase, but for a range of solubility for Al₃Pt₅. Subsequent studies failed to confirm Al₂Pt₃ [75Cha1, 78Bha].

[64Huc] identified a thermal arrest at 1260 °C and 50 to 60 at.% Pt as a $L \rightleftharpoons AlPt + Al_3Pt_5$ eutectic reaction. This identification seems implausible for several reasons. First, there is the substantial doubt of the existence of Al₂Pt₃. Second, this interpretation implies an implausibly steep liquidus slope in the vicinity of 57 at.% Pt. Third, metallographic studies by [75Cha1] of samples containing 59, 60, and 60.5 at.% Pt, heat treated at and quenched from 1300 °C, showed only Al₃Pt₅ and AlPt, the latter having apparently undergone a solid-state transformation. No chilled liquid was seen. [75Cha1] suggested that the AlPt observed may have been transformed from a high-temperature phase of CsCl structure. Subsequently, via high-temperature XRD, [78Bha] confirmed the existence of the high-temperature phase of CsCl structure in a sample containing 53 at.% Pt that was single phase at 1340 °C. The phase admixture at 1208 °C was AlPt + Al₃Pt₅; that at 1272 °C was AlPt + β . No indication of liquefaction was reported. Consequently, the arrest observed by [64Huc] at 1260 °C probably corresponds to the $\beta \rightleftharpoons AlPt + Al_3Pt_5$ eutectoid decomposition.

Fig. 1 Assessed Al-Pt Phase Diagram



A.J. McAlister and D.J. Kahan, 1986.

Two (Pt) solidus points obtained metallographically by [70Dar] agree well with the [64Huc] thermal (Pt) solidus data.

Terminal Solubilities. [64Huc] reported Pt to be practically insoluble in (Al). They placed the $L \rightleftharpoons (Al) + Al_{21}Pt_5$ eutectic temperature at 657 °C. Our extrapolation of the liquidus to this temperature places the eutectic composition at 0.44 at.% Pt. This concentration is in very good agreement with that inferred from the observed convergence of the coupled growth zone in the directional solidification studies of [80Pia]. Assuming no solubility of Pt in (Al) and a 3 °C depression of the eutectic temperature below the melting point, we obtain, by linear extrapolation of the partition coefficient at infinite dilution, an estimated eutectic composition of 0.45 at.% Pt. From the agreement of this value with the observed eutectic composition, we conclude that the assumption of essentially no solubility is valid.

Further inference of the solubility of Pt in (Al) can be made from the [74Ton] study of splat-quenched alloys containing up to 3 at.% Pt. In the as-quenched state up to 2 at.% Pt, only (Al) was detectable by XRD, with the lattice parameter decreasing linearly with composition. After heat treatment for 15 min at 300 °C, the (Al) lattice parameter was indistinguishable from that of pure Al. After allowance for the error limits of the XRD measurements, an extreme upper limit on the solubility of Pt in (Al) of 0.1 at.% Pt can be inferred, but we believe that it is considerably less, in view of the fact (see "Metastable Phases") that [74Ton] assumed partitionless solidification in the quenched liquid.

From the combined data of [64Huc] and [70Dar], we estimate that approximately 14 at.% Al dissolves in (Pt) at

1510 °C. X-ray lattice parameter studies yielded 10 at.% Al at 1200 °C [62Bro] and 10 and 5 at.% Al at 1000 °C and 300 °C [79Sch]. The (Pt) solvus data obtained by [70Dar] from microprobe analysis are not consistent with the [62Bro] and [79Sch] data or with their own metallographic results at high temperature.

$Al_{21}Pt_5$ vs Al_4Pt . Two phases in equilibrium with (Al) and the liquid near 657 °C have been reported. On the basis of XRD and density studies, [64Huc] identified the equilibrium phase as cubic, of $Al_{21}Pt_5$ composition. Directional solidification, XRD, and density studies of alloys near the eutectic composition by [80Pia] confirmed this identification. [78Sch] reported, without experimental detail, the equilibrium phase to be hexagonal, of Al_4Pt composition. [82Ell] confirmed the hexagonal phase via XRD studies of alloys heat treated at 597 °C for two days, containing 19, 20, and 21 at.% Pt, with the 20 at.% sample single phase.

However, [80Pia] also found the hexagonal phase in alloys of near, but hypereutectic, composition and gave its composition as $Al_{21}Pt_6$. Moreover, they noted slow but significant transformation of the hexagonal into the cubic phase over a period of several hours at 200 °C. Inspection of the thermal arrest data of [64Huc] near 657 and 806 °C reveals that with increasing Pt content both the eutectic arrest near 657 °C and the peritectic arrest near 806 °C lie slightly higher below 10 at.% Pt than above. These observations suggest that the hexagonal Al_4Pt phase is metastable and more easily nucleated at higher Pt content than the equilibrium cubic $Al_{21}Pt_5$ phase.

$Al_{21}Pt_6$, Al_2Pt , and $AlPt$. Experimental results for these phases are summarized in Tables 2 and 3. No further comment is needed.

The β Phase. The experimental evidence for the existence of this phase, metallographic data of [75Cha1] and high-temperature XRD data of [78Bha], are shown in Fig. 1. Interpretation of the thermal arrest observed at 1260 °C by [64Huc] as a $\beta \rightleftharpoons \text{AlPt} + \text{Al}_3\text{Pt}_5$ eutectoid was presented in the discussion of the liquidus. The peritectic reaction $\text{AlPt} + \text{L} \rightleftharpoons \beta$ has been introduced so that (1) no violent disagreement with liquidus arrest data of [64Huc] occurs, and (2) thermodynamically plausible curvatures of the $\beta/\beta + \text{L}$ and $\beta/\beta + \text{Al}_3\text{Pt}_5$ boundaries could be drawn. This is a speculative placement only, yielding a plausibly shaped β single-phase field.

AlPt_2 and $\text{AlPt}_2(\text{LT})$. AlPt_2 was reported by [75Cha1] and [76Cha] via metallography and XRD structural analysis; $\text{AlPt}_2(\text{LT})$ was reported by [75Cha1] and [75Cha2], the latter via diffusion couples and microprobe analysis. [68Fer] reported an extremum in heat of formation data at about 67 at.% Pt. [76Gue], however, performed microprobe analyses on samples containing 66.5 at.% Pt, heat treated at temperatures from 500 to 1350 °C, and found only compositions corresponding to AlPt_3 and Al_3Pt_5 . These experiments might be considered to cast doubt on existence of the AlPt_2 phases, because the heat treatment times of [76Gue] considerably exceeded those of [75Cha1]. However, [75Cha1] carried out heat treatment in Al_2O_3 crucibles sealed in evacuated quartz ampoules, whereas the [76Gue] heat treatments were carried out in argon backfilled quartz ampoules. The use of silica alone poses a danger of Si contamination, and destabilization of the AlPt_2 phases may have occurred in such a situation. The weight of evidence seems to favor the occurrence of AlPt_2 and $\text{AlPt}_2(\text{LT})$ as stable equilibrium binary phases. The nature and temperatures of the reactions between 1050 and 1125 °C are unknown. Following [75Cha1], we have presented them in Fig. 1 by a dashed horizontal at 1060 °C.

AlPt_3 and $\text{AlPt}_3(\text{LT})$. AlPt_3 was shown to have cubic Cu_3Au structure by [58Kle], [62Bro], [63Mag], [64Huc], and [75Cha1]. The present placement of the boundaries of the AlPt_3 phase near 1500 °C relies on the thermal analysis data of [64Huc] and the metallographic data of [70Dar]. Between 1050 and 1250 °C, X-ray structural and metallographic data of [62Bro] and [75Cha1] are used. The tetragonal structure of the low-temperature modification, $\text{AlPt}_3(\text{LT})$, was identified by [62Bro], [64Huc], and [75Cha1]. [75Cha1] showed that the unit cell described by [62Bro] and [64Huc] is not the primitive cell. [64Huc] noted that $\text{AlPt}_3(\text{LT})$ forms on cooling to 1280 °C and below, without observable heat release. The character of the invariant reaction is not clear. The congruent transformation at 1290 °C and the related eutectoid reaction $\text{AlPt}_3 \rightleftharpoons \text{AlPt}_3(\text{LT}) + (\text{Pt})$ at 1280 °C (Fig. 1) were sketched as possibilities by [75Cha1] and are adopted here. Neither [70Dar] nor [76Gue] confirmed the existence of the $\text{AlPt}_3(\text{LT})$ modification, but neither considered that their experiments excluded its existence. Metallographic data of [62Bro] and [75Cha1] are shown in Fig. 1.

Metastable Phases

In a thin-film diffusion couple of 50 at.% Pt (Al over Pt on a mica substrate, heat treated at 410 °C) [64Com] found an

fcc phase with lattice parameter, 0.410 ± 0.001 nm, larger than that of Al. This phase, whose composition could not be determined, grew when the sample was cooled below 410 °C. It is labeled α' in Table 2. Possibly, it grows epitaxially and metastably from the mica substrate.

Al_6Pt was observed by [80Pia] and [82Ell] and reported without experimental detail by [75Cha1] and [78Sch]. Evidence for its metastability has already been presented.

[74Ton] splat quenched samples containing 0 to 3 at.% Pt. In samples containing 2 at.% Pt or less, no X-ray lines other than those of fcc (Al) were observed, and the lattice spacing dropped linearly from the pure Al value to approximately 0.4026 nm at 2 at.% Pt (prequenched liquid composition). When such samples were heated at 300 °C for 15 min, lattice spacings became indistinguishable from pure Al. Hence, a metastable solubility of ~ 2 at.% Pt was inferred. (A cautionary note is raised by the work of [79Cha], discussed below). In other samples, containing from 2 to 3 at.% Pt, [74Ton] observed a metastable phase which they classified as tetragonal, with $a = 1.358$ and $c = 1.665$ nm, with nominal composition Al_6Pt . In a sequence of 15 min heat treatments at various temperatures, Al_6Pt transformed completely to the cubic $\text{Al}_{21}\text{Pt}_5$ phase at 650 °C.

[78Cha] and [79Cha] examined splat-quenched alloys containing 1 at.% Pt by X-ray and electron diffraction. In as-quenched foils, XRD showed broad (Al) lines plus weak extra lines. Electron diffraction indicated that the extra lines arose from an extremely fine precipitate of a cubic phase, with lattice parameter 0.567 ± 0.003 nm. This was interpreted as a metastable extension of Al_2Pt . This phase is labeled ϵ' in Table 2. In aged samples, another phase of nominal composition Al_6Pt was observed and classified as orthorhombic, with $a = 1.5762$, $b = 1.2103$, and $c = 0.8313$ nm. [78Cha] noted that this structure reproduces the XRD pattern observed by [74Ton] quite well, except at very low scattering angles. Probably, the same phase was observed by [74Ton], [78Cha], and [79Cha] and its actual structure is orthorhombic. For present purposes, we accept that the three investigators observed the same phase and further accept the [78Cha] indexing.

There remains the possibility that fine precipitates of Al_6Pt may have been present in the as-quenched [74Ton] samples. If so, the metastable solubility of Pt in (Al) inferred by [74Ton] may be in significant error, in view of their assumption of partitionless solidification. However, the splat-quenched product is well known to vary considerably with such factors as sample thickness and local quench rate; consequently, no conclusive judgment can be made on this point.

In splat-quenched samples containing 1 to 53 at.% Pt, [82Ell] observed by XRD an un-indexable phase that disappeared (in most cases) on annealing at 597 °C. It is denoted λ' in Table 2.

Thermodynamics

[68Fer] determined the heats of formation of solid Al-Pt alloys in the composition range 18 to 94 at.% Pt by solution calorimetry. The results are listed in Table 4.

Table 4 Al-Pt Enthalpies of Formation from Solution Calorimetry [68Fer]

Composition, at.% Pt	Enthalpy of formation (-Δ _f H), J/mol	Composition, at.% Pt	Enthalpy of formation (-Δ _f H), J/mol
17.7.....	50 200	50.5.....	100 400
19.8.....	57 300	58.5.....	92 900
26.5.....	71 128	63.6.....	87 800
37.4.....	100 416	67.8.....	88 300
42.....	95 000	74.....	71 100
42.....	88 000	74.7.....	69 900
48.7.....	92 000	94.2.....	18 400
50.2.....	101 700		

By an electrochemical cell technique, [81Wor] measured the Gibbs energy of mixing at 75 at.% Pt to be $-76\,460 + 7.48 T$ J/mol of atoms. A comparable heat of formation at 74.7 at.% Pt is $-69\,900$ J/mol of atoms [68Fer].

[78Sch] measured the Al partial Gibbs energy of mixing by the electrochemical cell method in the composition range 85 to 98.5 at.% Pt and from 700 to 800 °C. (Pt) solvus values in agreement with the X-ray lattice parameter results of [79Sch] were obtained.

Cited References

- 12Cho1:** M. Chouriguine, "On the Alloys of Pt with Al," *Compt. Rend.*, **155**, 156-158 (1912) in German. (Equi Diagram; Experimental)
- 12Cho2:** M. Chouriguine, "On the Alloys of Pt with Al," *Rev. Metall.*, **9**, 874-883 (1912) in German. (Equi Diagram; Experimental)
- 37Zin:** E. Zintl, A. Harder, and W. Haucke, "Alloy Phases with Fluorite Structure," *Z. Phys. Chem.*, **B35**, 354-362 (1937) in German. (Crys Structure; Experimental)
- 56Sch:** K. Schubert, W. Burkhardt, P. Esslinger, E. Gunzel, H. Meissner, W. Schutt, J. Wegst, and M. Wilkens, "Several Structural Results on Metallic Phases," *Naturwissenschaften*, **43**, 248-249 (1956) in German. (Crys Structure; Experimental)
- 58Kle:** W. Klemm, F. Dorn, and R. Huch, "Investigations of the System Al-Pt," *Naturwissenschaften*, **45**, 490 (1958) in German. (Crys Structure; Experimental)
- 62Bro:** W. Bronger and W. Klemm, "Preparation of Alloys of Pt with Non-Noble Metals," *Z. Anorg. Chem.*, **319**, 58-81 (1962) in German. (Equi Diagram, Crys Structure; Experimental)
- 63Fer:** R. Ferro, R. Capelli, and G. Rambaldi, "Research on Alloys of Noble Metals with Less Electropositive Elements—VI. Micrographic and X-Ray Examination of Some Al-Pt Alloys," *Atti Accad. Naz. Lincei, Rend. Classe Sci. Fis. Mat. Nat.*, **34**, 45-47 (1963) in German. (Crys Structure; Experimental)
- 63Mag:** A. Magneli, L. Edshammar, and T. Dagerhamm, "Phase Analysis and Crystal Structure Studies in Binary Alloys of Al with Transition Metals," Final Tech. Rep. No. 1 under Contract No. DA-91-591-EUC-2734 (AD 426927), 44-50 (1963). (Equi Diagram, Crys Structure; Experimental)
- 64Com:** J.J. Comer, "Electron Diffraction Data on New Compounds in the System Al-Pt," *Acta Crystallogr.*, **17**, 444-445 (1964). (Crys Structure; Experimental)

- *64Huc:** R. Huch and W. Klemm, "The System Pt-Al," *Z. Anorg. Chem.*, **329**, 123-135 (1964) in German. (Equi Diagram, Crys Structure; Experimental)
- 68Eds:** L.E. Edshammar, "Crystal Structure of Pt₃Al₂₁," *Acta Crystallogr.*, **20**, 2683-2688 (1968). (Crys Structure; Experimental)
- 68Fer:** R. Ferro, R. Capelli, A. Borsese, and G. Centineo, "Research on Alloys of Noble Metals with Less Electropositive Elements. XII—Heats of Formation of Al-Pt Alloys," *Atti Accad. Naz. Lincei, Classe Sci. Fis. Mat. Nat.*, **45**, 54-59 (1968) in German. (Thermo; Experimental)
- 70Dar:** A.S. Darling, G.L. Selman, and R. Rushforth, "Pt and the Refractory Oxides III — Constitutional Relations in the Alloys Formed," *Platinum Met. Rev.*, **14**, 124-130 (1970). (Equi Diagram; Experimental)
- 74Ton:** A.M. Tonejc, A. Tonejc, and A. Bonafacic, "Non-Equilibrium Phases in Al-Rich Al-Pt Alloys," *J. Mater. Sci.*, **9**, 523-526 (1974). (Meta Phases; Experimental)
- *75Cha1:** T. Chattopadhyay and K. Schubert, "Crystal Structure of Pt₃Ga(r) and Several Phases of the Pt-Al System," *J. Less-Common Met.*, **41**, 19-32 (1975). (Equi Diagram, Crys Structure; Experimental)
- 75Cha2:** D. Chatterji, R.C. Devries, and J.F. Fleischer, "Investigation of Sub-Solidus Equilibria in the Pt-Al System Using Diffusion Couples," *J. Less-Common Met.*, **42**, 87-198 (1975). (Equi Diagram; Experimental)
- 76Cha:** T. Chattopadhyay and K. Schubert, "Crystal Structure of Pt₂Al·r," *J. Less-Common Met.*, **45**, 79-83 (1976). (Crys Structure; Experimental)
- 76Gue:** P. Guex and S. Feshotte, "The Binary Systems Pt-Al, Pt-Ga, and Pt-In," *J. Less-Common Met.*, **46**, 101-116 (1976). (Equi Diagram; Experimental)
- 78Bha:** S. Bhan and H. Kudielka, "Ordered bcc Phases at High Temperatures in Alloys of Transition Metals and B-Subgroup Elements," *Z. Metallkd.*, **69**, 333-334 (1978) in German. (Equi Diagram, Crys Structure; Experimental)
- 78Cha:** K. Chattopadhyay and S. Lele, "On A₁₂M-Type Phases in Splat-Cooled Al-Alloys," *J. Mater. Sci.*, **13**, 2730-2731 (1978). (Meta Phases, Crys Structure; Experimental)
- 78Sch:** K. Schubert, "On the Binding in Phases in Mixtures T₁₀B₃-N Prime," *Z. Krist.*, **148**, 193-206 (1978) in German. (Crys Structure; Review)
- 79Cha:** K. Chattopadhyay and P. Ramachandrarao, "Metastable Formation and Decomposition in a Rapidly Solidified Al-Pt Alloy," *Mater. Sci. Eng.*, **38**, 7-17 (1979). (Meta Phases, Crys Structure; Experimental)
- 79Sch:** M.J. Schaller, "Magnetic Properties and Lattice Parameters of Pt Solid Solutions," *Z. Metallkd.*, **70**, 318-321 (1979) in German. (Equi Diagram, Crys Structure; Experimental)
- *80Pia:** G. Piatti and G. Pellegrini, "Structure of Unidirectionally Solidified Al-Al₂₁Pt₅ Alloys," *J. Mater. Sci.*, **15**, 2403-2408 (1980). (Equi Diagram, Crys Structure; Experimental)
- 81Wor:** W.L. Worrel and T.A. Ramanarayanan, "Electrochemical Cell Investigations of Pt Binary Systems," *Chemical Metallurgy—A Tribute to Carl Wagner*, TMS-AIME, Warrendale, PA, 69-74 (1981). (Thermo; Experimental)
- *82Ell:** M. Ellner, U. Kattner, and B. Predel, "Constitutional and Structural Investigations on the Al-Rich Part of the Systems Ni-Al and Pt-Al," *J. Less-Common Met.*, **87**, 305-325 (1982). (Equi Diagram, Meta Phases; Experimental)

*Indicates key paper.

Al-Pt evaluation contributed by A.J. McAlister and D.J. Kahan, Center for Materials Science, National Bureau of Standards. This work was jointly funded by the Defense Advanced Research Project Agency (DARPA) and the National Bureau of Standards through the Metallurgy Division and through the Office of Standard Reference Data. Literature searched through 1983. Dr. McAlister is the ASM/NBS Data Program Co-Category Editor for binary aluminum alloys.